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Lower Esophageal Disorders in Childhood Evaluated by Transabdominal Ultrasound and Fluoroscopy: A Pictorial Essay

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Pediatric lower esophageal disorders and diseases are rare in the pediatric population. The most common include hiatus hernia, achalasia, duplication cyst, esophageal varices, and esophagitis. In all these disorders transabdominal sonography and fluoroscopy are able to provide substantial diagnostic data, including both morphologic and functional information of the lower esophagus. The educational objective of this pictorial essay is to review the technique of esophageal ultrasound and fluoroscopy, as well as the imaging findings of the commonest pediatric lower esophageal disorders.

Esophageal Fluoroscopy Technique

Esophageal fluoroscopy is performed after adequate fasting of the child, with the use of contrast material, most commonly barium sulfate. The contrast media is delivered by a baby bottle in infants and small children, or taken from a cup in older children. The examination begins with the child in the lateral projection, obtaining images from the nasopharynx to the esophagogastric junction as well as the stomach fundus. Subsequently the child lies supine, to examine the esophagus in the anteroposterior projection. The anatomic course, the calibre, the mucosal surface of the esophagus, and the position of the gastroesophageal junction should be evaluated. In addition, esophageal peristalsis should be assessed and possible reflux should be documented

(Figures 1 and 2). Further imaging of the remainder of the stomach and the duodenum is usually performed, which will not be assessed in this essay. The ALARA (As Low As Reasonably Achievable) principle should always be applied, to keep radiation dose low [1].

Esophageal Sonography Technique

The evaluation of the distal esophagus should be performed in quiet and calm infants after giving a weight-related food amount (milk or chamomile) for filling the stomach sufficiently. Children should be examined in the supine and anterior oblique positions, and in some cases in the erect position. The examination should be performed with a curvilinear transducer of 5-8 MHz or a linear high frequency transducer, using the left hepatic lobe as acoustic window [2,3]. In longitudinal section, the esophagus is revealed as a tubular structure consisted of 2 hypoechoic peripheral bands, which represent the muscular layers and a central hyperechoic line, which represents the mucosa and collapsed lumen. In cross-sectional images esophagus appears as a target with a hypoechoic peripheral ring, which represents its muscular layer and a hyperechoic centre, the mucosa and collapsed lumen. Some ultrasound measurements should be made when necessary, for precise evaluation of esophageal disorders. Abdominal esophageal length should be measured at the end of a normal exhalation, from the point at which the esophagus penetrates the diaphragm, to the base of the triangular pad of gastric folds at the anterior surface of the fundus of the stomach. The mean length normally ranges

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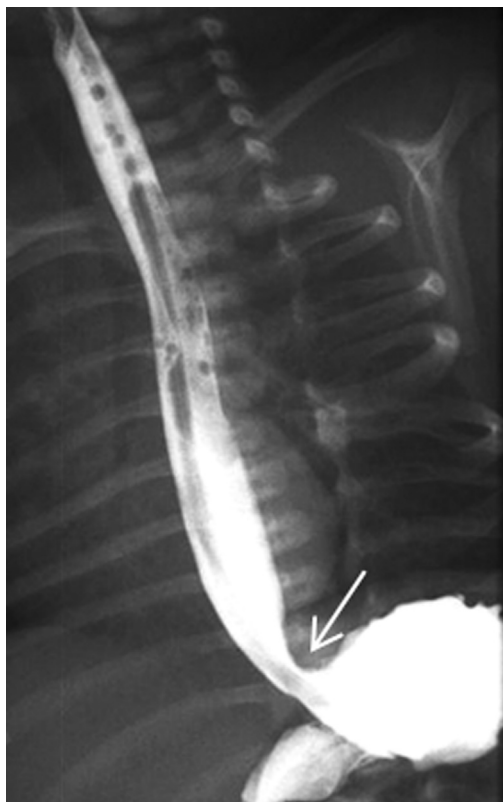


Figure 1. Gastroesophageal reflux. Esophageal fluoroscopy in a 2-month-old boy with recurrent vomiting demonstrates gastroesophageal reflux up to the intrathoracic esophagus. The gastroesophageal angle is normal (arrow).

from 22.2 mm in newborns to 27.2 mm in 1-year-old infants and exceeds up to 34 mm in children older than 6 years of age [2,3] (Figures 3A and 3B). In the same view the gastroesophageal angle (angle of His) can be measured, between the abdominal esophagus and the posterior gastric wall: an angle of 70°-100° is considered normal, whereas 100-130° is obtuse and 130°-180° is completely obtuse (Figure 4). The total esophageal diameter should be 10 mm normally, and the esophageal wall thickness (defined as the total hypoechoic layer and measured on the anterior wall at the midpoint of the abdominal esophagus) measures from 2.1-5.7 mm, depending on the age of the child [3] (Figure 5).

Imaging Findings

Hiatal Hernia

Hiatal hernia is a herniation of the gastroesophageal junction and part of the stomach through the esophageal hiatus of the diaphragm into the mediastinum. There are 3 types of hiatal hernia: sliding hernia, paraesophageal hernia, and congenital short esophagus [4].

In sliding hernia, a widened hiatus permits upward movement of the gastroesophageal junction and the cardia of stomach into the chest. It represents more than 95% of all hiatal hernias and is often associated with gross gastroesophageal reflux [2,4,5].



Figure 2. Gastroesophageal reflux. Esophageal fluoroscopy in a 3-month-old boy with recurrent vomiting demonstrates gross gastroesophageal reflux up to the upper esophagus. The esophagus is dilated, with wide opening of its intra-abdominal part and the gastroesophageal angle is obtuse (thin arrow). Note the dysplastic ribs on the left hemithorax (thick arrow).

Fluoroscopy can easily demonstrate the sliding hernia, depicting the gastroesophageal junction located above the diaphragmatic hiatus (Figure 6).

Sonography, having the advantage of no radiation exposure, is also a reliable diagnostic tool. It can demonstrate: 1) the presence of severe GER, 2) a short abdominal esophagus, 3) an increased gastroesophageal angle of more than 130°, and 4) an enlarged “beak” at the gastroesophageal junction with a wide opening of gastroesophageal junction [4,5] (Figure 7). During real time examination sliding of the stomach fundus towards the diaphragm is observed [2].

In paraesophageal hernia, part of the stomach herniates through the esophageal hiatus, whereas the gastroesophageal junction remains in its normal location [4]. This type of hernia does not relate to gastroesophageal reflux disease (GERD), and may present with respiratory tract symptoms and vomiting.

Fluoroscopy can reveal the normal position of gastroesophageal junction and the presence of stomach above the hiatus (Figure 8). This may also be demonstrated by transabdominal sonography, after adequate filling of the stomach (Figure 9).

Further imaging is usually not required, although in some cases esophageal endoscopy is also performed.

Achalasia

The term *achalasia* is used to describe an abnormal lower esophageal sphincter relaxation in response to deglutition [6,7]. Distal esophageal achalasia is a rare primary motility disorder in the pediatric population, with an annual incidence of 1 in 100,000 [6,7]. The most

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